

EE392N Project Proposal

The Concept: One of the group members is currently developing an energy project in the north of Chile. The idea is very transparent: *“to produce high quality 24/7 electricity with solar power, at a price competitive with local fossil fuel generation, without subsidies”*, the execution is not.

The Project: To explore the viability of a utility scale solar project that takes advantage of natural topography to provide consistent electricity. The project is currently sized to provide 150 MW of constant power at 90% yearly availability. This requires a massive solar plant of about 438 MW_p, located at very high altitude¹ (12,000 feet above sea level) with its respective substation; a 298 MW pumped storage running on seawater on the coast of Atacama, with its respective substation; a 78 mile transmission line connecting the solar plant with the pumped hydro; a 19 mile interconnection transmission line running from the pumped storage substation to a major substation of the Chilean Northern Grid.

The Research: In order to be able to provide a constant stream of power at the point of interconnection with the grid, the pumped storage needs to be able to compensate any fluctuations of the solar plant during the day, and provide 100% of the required power at night. Further research can help to address technicalities of this arrangement summarized below,

¹ Given that in the Atacama Desert is possible to find perfectly flat surfaces at high altitude, it is possible to extract additional output from PV panels by maximizing solar irradiation (less atmosphere and particulate material) and minimizing operating temperature (models anticipate an average of around 0 degrees Celsius during the day).

- i. In case of even residual cloud cover, the solar plant power output drops. This needs to be compensated in real time (<3 seconds reaction time) by the pumped storage. At the very least, such a system requires synchrophasors in both PS and PV substations; and multiple bird eyes on the solar plant that are able to read the sky and, along processing equipment, are able to make a high probability prognosis of the solar plant output on a continuous window from 15 seconds to 25 minutes into the future. Further field studies can help explore the viability and accuracy of such system.
- ii. The pumped storage is a phenomenal ancillary services provider, but there are caveats. On the generation side, a turbine can produce output from 25% to 100% of nominal capacity, giving a very broad range of flexibility. However, on a traditional motor/generator, the pumping has no flexibility and can only work at nominal capacity. The advent of variable speed motors changed the equation, by effectively allowing to change frequency and voltage, which allows the system to operate on a range between 70% and 100% of nominal capacity. While this is a massive improvement, in the context of a solar plant, the morning and evening tails are complex. Additional studies are required to evaluate the impact of the tails on the project.

The Benefit: With these challenges solved, this project would result in a significant achievement: on-demand 24/7 electricity with solar power that is competitive with fossil fuel generation, at a scale that is considerable for the Chilean economy.